On 10 June, no stripe rust was found in the Mosses Lake area in central Washington. Low levels of stripe rust were found in the susceptible spreader rows in the rust-monitoring nursery at the Lind Dryland Experiment Station in east central Washington. In mid-June, wheat stripe rust was severe on susceptible spreader rows in the winter wheat nurseries near Pullman, Washington but few winter wheat entries in the nurseries had stripe rust. No stripe rust was found in the spring wheat and barley nurseries or fields near Pullman. In general, stripe rust infections were low in the eastern Pacific Northwest.

In early July, wheat stripe rust was developing at a slow pace in the Pacific Northwest due to the dry and hot weather conditions. No rust was found in winter wheat fields in the Palouse area. Low levels of stripe rust were found in spring wheat fields in east central Washington. On 1 July, highly susceptible winter wheat entries in experimental fields at Walla Walla in southeastern Washington had 80% stripe rust severities.

In mid-June, high levels of wheat stripe rust were reported on susceptible winter wheat and low levels on spring wheat plants in nurseries at the Pendleton Experiment Station in northeastern Oregon. In late June, high levels of stripe rust were found in susceptible winter wheat entries in nurseries at Corvalis, Oregon, and Moscow, Idaho. In Pendleton and Hermiston, Oregon, nurseries susceptible spring wheat entries had stripe 20% rust severities.

NEBRASKA

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P.S. Baenziger, D. Baltensperger, L. Nelson, I. Dweikat, A. Mitra, T. Clemente, S. Sato, S. Wegulo, and G. Hein (University of Nebraska), and R.A. Graybosch, R. French, and Satyanarayana Tatineni (USDA–ARS).

Wheat production.

In 2008, 1,750,000 acres of wheat were planted in Nebraska and 1,670,000 were harvested with an average yield of 44 bu/acre for a total production of 73,500,000 bu. The autumn generally was conducive to good emergence in these parts of the state. Planting in eastern Nebraska was subject to heavy rains that delayed planting and hurt emergence after planting. Hence, the eastern wheat crop got off to a bad start that unfortunately carried forward through the rest of the growing season. The winter was relatively mild and winterkilling was minor. The spring growing season began and stayed on the dry side in parts of western Nebraska, thus reducing diseases other than viruses, but did cause concerns for drought damage. However, much of eastern Nebraska had ample moisture during flowering and grainfill leading to leaf diseases, and Fusarium head blight, which again was a major concern. In the south-central and eastern parts of the state, early season diseases included powdery mildew, tan spot, and Septoria leaf blotch. Despite the wetness, leaf rust did not develop to damaging levels (except in some susceptible lines or cultivars) because the inoculum (rust spores) blown into Nebraska from southern states was limited. In western Nebraska, wheat streak mosaic virus was present as was loose smut and common bunt (syn. stinking smut). For the first time, *Triticum* mosaic virus was confirmed in Nebraska. Wheat stem sawfly in the panhandle continued to expand its presence with severe infestations being found for the first time in central Box Butte County.

In 2009, the most popular and most widely grown wheat cultivar was Agripro Jagalene (13.8% of the state) followed by Millennium (13.2%), Pronghorn (12.1%), TAM 111 (6.5%), Alliance (6.1%), Goodstreak (5.0%), and Wesley (4.8%). Pronghorn and Goodstreak are tall (conventional height) wheat cultivars that have consistently done well in the drought prone areas of western Nebraska where tall wheat cultivars are increasingly being planted.

Increase of new experimental lines.

P.S. Baenziger.

Two lines are under increase NE01481 and NI04421. NE01481 is being evaluated for the Southeastern NE and the organic market. It has superior end use quality, soilborne wheat mosaic virus resistance (a rarity among our lines), and very high grain yield for Southeast NE. We view it as an excellent new experimental line with a trait that is valuable to a part of our state that we have had difficulty finding good new cultivars with the right disease resistances. NI04421 is targeted for irrigated production systems where it has preformed extremely well. It has acceptable end-use quality and disease resistance with one exception. It is very susceptible to stinking smut. Additional information about our breeding program can be found at http://agronomy.unl.edu/grain/WHTANN08F.PDF.

Winter triticale nursery.

P.S. Baenziger and K. Vogel.

In 2008, no new triticale lines were recommended for release; however, we selected nine lines for increase (five small and four large) as possible replacements or to complement NE426GT and NE422T, which continue to perform well. Because triticale is a small market crop, we are carefully deciding how best to release new triticale cultivars so as to not cause inventory problems with the previously released cultivars. We now are beginning to move to higher and more consistent grain yield levels, but identifying excellent forage types requires forage harvesting, which is expensive and difficult for widespread trials. Although the markets for biofuels fluctuate with the price of oil and other geologically based fuels, we believe that there is a future for triticale in a biobased energy system. Triticale can be grown over the winter as forage or grain crop in areas where maize cannot be grown successfully. The grain will substitute for maize in animal rations and the forage can be used as forage, cellulosic ethanol feed stocks, or as a ground cover.

Wheat transformation and tissue culture studies.

N. Mengistu, T. Clemente, S. Sato, S. Wegulo, J. Counsells, and P.S. Baenziger.

Wheat transformation continues to be a key strategic effort in the wheat improvement overall effort. Mr. Neway Mengistu, a graduate student on the project, is genetically characterizing and evaluating some lines with possible Fusarium head blight resistance genes. In addition, Dr. Clemente is adding some new transgenes with novel sweetener and fiber characteristics that may enhance end-use quality as a potential value added trait.

Chromosome substitution lines.

M.D. Ali, N. Mengistu, A. Bakhsh, P.S Baenziger, I. Dweikat, K. Eskridge, K. Gill, and M. Kazi.

This research was undertaken with the expectation as we learn more about the wheat genome; we would be able to develop better breeding strategies. Dr. Md. Liakat Ali is currently summarizing data on 223 recombinant inbred chromosome lines in a Cheyenne background for chromosome 3A (CNN(RICL3A)) in a four-replicated trial in six trials (Mead, 2005, 2006, and 2007; Sidney, 2005; Lincoln, 2006, North Platte, 2007). this research. We continue testing in replicated trials recombinant chromosome lines involving both chromosomes 3A and 6A in a Cheyenne background (CNN(RICL3A+6A)) to study epistasis (led by Mr. Ali Bakhsh, a new student in our project). Mr. Neway Mengistu is studying in replicated trials at Lincoln, Mead, and North Platte, 90 WI(RICL3A)s to compare to our CNN(RICL3A)s and CNN(RICL3A+6A)s studies. Preliminary results suggest that the yield reducing QTL from CNN in the WI background maps to the same location and the yield increasing QTL from WI mapped in the CNN background. Dr. Mujeeb Kazi created these lines for us using doubled haploid techniques and we are very appreciative of his efforts.

Collaborative research on wheat diseases.

J. Sidiqi, N. Mengistu, S. Wegulo, F. Dowell, and P.S. Baenziger.

The major event in stem rust research is the emergence of a new race Ug99 that can overcome most of the previously very durable resistance genes in wheat, which were the main genes used in our program. Hence, this is a huge potential loss for our breeding efforts. *Sr2* (found in Scout 66 but is associated with false or pseudo black chaff), appears to be one of the few commonly used genes available. We are rapidly incorporating new stem rust genes (*Sr25, Sr26, Sr39, and Sr40*), but the rapid loss of so many resistance genes in unprecedented in my lifetime. Interestingly Sr_{Tmp}, which is found in many of our lines, including NE01643 is resistant to Ug99, but not to some of the races found in the United States. Mr. Javed Sidiqi, a Fulbright scholar from Afghanistan, screened 505 lines from Central Asia (430 from Afghanistan, 25 from Pakistan, 25 from Iran, and 25 from Tajikistan) and only two modern lines from Afghanistan were resistant to stem rust race TPMK (a surrogate race that is present in the U.S.). Working with Dr. Yue Jin, the four most resistant lines were screened to Ug99 in his carefully confined testing facility and all were found to be susceptible to Ug99. This result confirms the extreme vulnerability of the Central Asian wheat crop to this new race.

Molecular markers are becoming an important aspect of our research on developing Fusarium head blightresistant lines. This year we began screening all three way cross F_1 seed to identify those carrying FHB QTL so as to enhance the frequency of the QTL in our populations. In the F_2 and possibly F_3 bulk generations, we are using optical sorting to enrich the populations for kernel hardness (remove the soft kernel genotypes). Currently, experiments to determine the efficacy of optical sorting for hardness and protein content are underway with Dr. Floyd Dowell of the USDA–ARS, Manhattan, KS. In this approach, at the minimum, we should create populations that are fixed for the 3BS QTL (*Fhb1*), enriched for other FHB QTL, and selected for hardness prior to visual selection for plant type. The FHB research is supported by a grand from the USDA–National Wheat and Barley Scab Initiative program, which also funds part of Mr. Mengistu's research.

Plant height and diversity in wheat.

Z. Al-Ajlouni, I. Dweikat, G. Bai, K. Eskridge, and P.S. Baenziger

We are interested in knowing if Rht_1 or Rht_2 may have better height characteristics in our tall and short plant height environments. Virtually all of our lines have the Rht_1 gene and only two lines may have had Rht_2. The most surprising result was that although many of lines have markers associated major dwarfing genes, the gene effects were missing (hence the markers were not diagnostic of the gene in our populations). None was more surprising than Cheyenne having the marker for *Rht8*, a gibberellic-sensitive dwarfing gene. There are many different responses to the environment for lines with Rht_1, which we believe can best be explained by unknown modifier genes in the background that affect of Rht_1.

Coordinated agriculture project: Applied Wheat Genomics.

N. Crowley, I. Dweikat, K. Eskridge, and P.S. Baenziger.

We are genotyping and phenotyping a mapping population of 154 F_6-derived recombinant inbred lines of 'TAM 107-R7/ Arlin' in collaboration with Pat Byrne and Scott Haley of Colorado State University. We submitted our marker data set and linkage map including 436 markers, a mixture of SSR, DArT, HMW- and LMW-glutenins, and morphological markers in June 2008. The linkage map covers approximately 2,120 cM, with a density of 6.44 cM/marker. The population has been submitted into the National Small Grains Collection with the accession numbers in GRIN: GSTR 11601–11756 and is available upon request. We harvested our first field trails in 2008 and have repeated the field experiments in 2008–09, which includes two sites in Texas. This research is supported by a grand from the USDA–CSREES–NRI (Proj. No. 2006-55606-16629) competitive grants program.

Genetic diversity in Turkish and Nebraska cultivars.

A. Auvuchananon, I. Dweikat, K. Eskridge, S. Dere (deceased), and P.S. Baenziger.

Ms. Anyamanee Auvuchanon is studying the relationship between U.S. and Turkish wheat lines. In her study, she is evaluating 23 U.S. Great Plains wheat and 22 Turkish wheat lines. In 1874, Turkey red winter wheat was brought to the Great Plains and became the most widely grown wheat in the United States. Since then, the Turkish and U.S. breeding programs have interacted, but often used different germ plasm. This study suggests that modern Great Plains wheat cultivars diverged from Turkish wheat cultivars by breeding for adaptation since only historic Great Plains wheat cultivars had a close relationship with Turkish wheat cultivars using the various clustering programs to determine similarity. For Great Plains wheat improvement, it may be possible to use those Turkish wheat cultivars that have agronomic merit and are most closely related to the Great Plains wheat cultivars as parents to add new alleles without adding so much genetic diversity as to make it hard to find the useful alleles.

Genetics of white flour and noodle color in wheat.

P.S. Baenziger, R.A. Graybosch, and Somrudee Onto.

Ms. Somrudee Onto, PhD student, is studying the genetics grain polyphenol oxidases (PPO), enzymes involved in discoloration of white flour and noodle color. Most Nebraska-bred hard white wheats have been found to carry wild-type alleles at the *Ppo-2A* and *Ppo-2D* loci. A newly released HWW, Anton, was found to carry both low levels of grain PPO, and, based on results with the STS marker PPO18, a mutant allele at *Ppo-2A*.

Breeding wheat for organic production systems.

R. Little, P.S. Baenziger, L. Xu, and V. Schegel.

Wheat breeding research for organic systems was initiated in 2008 through a USDA–CSEERS grant (Proj. No. 2007–51300–03785) on certified organic land at four Nebraska research stations. An additional component of this project is to develop production systems utilizing cover crops and winter wheat in organic systems. Testing in organic environments at UNL begins at the F_6 generation with unreplicated yield trials. The F_6 nursery plus F_7 (early replicated yield trial) and F_8–F_{12} (Nebraska interstate Nursery—NIN) nurseries are grown on organic land at two locations, Mead and Sidney. The F_{10}–F_{12} (Organic State Cultivar Trial) nursery is grown at four locations of which three also have conventional State Cultivar Trials for comparison: Mead, Clay Center, and Sidney. Concord (Haskell) has only an organic cultivar trial. Based on discussions with organic small grains producers, an initial list of ideal winter wheat cultivar traits was used as the basis for screening in 2008: 1) competitive grain yield, 2) excellent end-use quality, 3) the ability to extract soil nutrients, 4) excellent disease and insect resistance, and 5) the ability to provide early season ground cover to suppress or tolerate weeds.

Yield. Many yield rank changes were expressed between organic and conventional lines in the NIN trials. Ironically, the line that did best in our elite trial grown in organic conditions was NH03614 (released as Settler CL), an herbicide-resistant wheat that is unlikely to be used in organic production. For the three locations with both organic and conventional plots, 2145 and NI04421 (most likely due to its being very susceptible to common bunt (or stinking smut) yielded much lower in organic plots than in conventional plots, whereas Overland was consistently high in both systems. This change of ranks is reflected in a highly significant system by entry interaction (P<.0001). In the three eastern locations, the long, cool, early summer seemed to favor tall cultivars including Goodstreak and Pronghorn. Goodstreak consistently outyielded all other cultivars at all three locations. Darrell was the most consistent in yield rank next to Goodstreak and performed the best for canopy cover (light bar readings) at jointing stage across locations. One new line with an excellent yield record in eastern Nebraska, NE01481, that also has great baking quality (yet poor milling quality) and very good disease resistance (including soilborne mosaic virus resistance, rare in our releases), is being increased for conventional and organic production.

Quality. Good USDA–ARS milling, mixing, and baking ratings from previous years were supported in 2008 for Pronghorn, Wesley, Alice, and Millennium. The promising USDA milling and baking quality for three experimental lines

(NW03681, NE04424, and NE04490) was supported. High protein content was responsible for all good mixing and baking lines, except for NE04490. NE04490 baked well and Hatcher, Harry, Alliance, and NE03490 had acceptable baking quality in 2008 despite low protein, which indicates good protein quality.

Breeding and characterization of waxy wheats.

R. Graybosch, L.E. Hansen, and D. Jackson.

A winter waxy (amylose-free) wheat breeding line, NX04Y2107 was entered both in the USDA–ARS cördinated Northern Regional Performance Nursery and in the University of Nebraska Wheat Variety Trial. In trials in nine Nebraska counties, grain yield of NX04Y2107 was equal to or greater than that of Jagalene, the most widely grown wheat in Nebraska over the past five years. In Lancaster and Clay Counties in Eastern Nebraska, NX04Y2107 was the highest yielding entrant and was entered in these trials again for 2009. Three additional waxy wheat breeding lines were selected from 2008 field trials and were advanced to regional and statewide trials for further testing. Using starch derived from waxy and partial waxy (reduced amylose) durum wheats, we discovered that cross-linked waxy starches have much greater final viscosity after cooking than normal or partial waxy starches, and that mechanical blends of waxy and normal starch produces final viscosities different than both types alone.

Tolerance to preharvest sprouting.

R.A. Graybosch.

Populations based on the sprout-tolerant hard white winter wheat RioBlanco were used, in collaboration with USDA–ARS scientists at Manhattan, KS, to identify potential new quantitative trait loci linked to preharvest-sprouting tolerance. A highly efficient technique of screening for resistance to preharvest sprouting was developed, incorporating readings of treated spikes via use of a Li-Cor Leaf Area Meter. To verify the effect of the identified QTL, samples from five additional breeding populations were obtained from 2007 and 2008 field plantings. Evaluation of 2007 samples has been completed and 2008 evaluations are commencing.

Comings and goings.

Mr. Javed Sidiqi successfully completed his M.S. degree. Mr. Zakaria Aj-Alouni successfully completed his Ph.D. degree. We welcome Ms. Kayse Onweller as a new graduate student to our program. Finally, we welcome Dr. Dipak Santra, who is the new proso millet breeder in western Nebraska and who will be an invaluable coöperator on wheat research. Three visiting scientists joined our project: Dr. Munir Turk from Jordan, Dr. Xianming Chen from the Peoples Republic of China, and Dr. Xiyue Song from the Peoples Republic of China.

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OKLAHOMA

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Wheat extension and wheat management research.

Jeff T. Edwards.

The 2007–08 wheat production year was outstanding for most Oklahoma wheat producers. Average yield was 2,486 kg/ha on 1.82 x 10^6 total harvested hectares, resulting in total crop value of $1.082 billion. In most of the state, wheat yields were 50 to 75% higher than historical averages. Many producers reported dryland wheat yields in excess of 5,000 kg/ha, and several variety-trial test plots exceeded 6,000 kg/ha. These record yields were present despite a lackluster environment for wheat emergence and growth during autumn 2007. In fact, many fields did not emerge until late winter. Timely spring rainfalls, adequate soil nitrogen mineralization, and moderate temperatures throughout late spring and early summer, however, allowed wheat plants to tiller and recover from a late start.

One interesting phenomenon that emerged in 2008 was a yield increase associated with grazing in some of our experiments. Winter wheat in the southern Great Plains is commonly grazed by cattle from late autumn through late winter, but a yield penalty, not increase, is generally associated with this practice. In 2008, grazed treatments yielded as much as 600 kg/ha more than nongrazed treatments when both were sown in mid-September. Nongrazed treatments, however, yielded approximately 500 kg/ha more than grazed treatments when nongrazed plots were sown at an optimal mid-October date. These data reinforce a hypothesis shared among many dual-purpose wheat researchers that the earlier-than-optimal sowing date in dual-purpose wheat production system probably has equivalent or greater impact on grain yield than grazing by cattle.

Cultivar development and breeding research.

Brett F. Carver.

Proposals submitted by the Oklahoma Wheat Improvement Team have been accepted by the Oklahoma Agricultural Experiment Station for the release of **OK Rising** hard white wheat in early 2008 and **Billings** and **Pete** hard red winter wheat in early 2009.

OK Rising was tested as experimental line OK02522W in the Southern Regional Performance Nursery (SRPN) in harvest years 2006 and 2007. The naming of this cultivar was intended to coincide with the 100th anniversary of Oklahoma's statehood (1907–2007); the cultivar's namesake is a contemporary musical piece composed specifically for the centennial by Oklahomans Jimmy Webb and Vince Gill, entitled 'Oklahoma Rising'. The name OK Rising also was intended to show linkage with its closely related HRWW counterpart and sister line, OK Bullet. Both OK Bullet and OK Rising came from the cross 'Jagger/KS96WGRC39'.

Substantial genetic improvement has been realized in the US HWWW class in the past decade, such that HWWW wheat lacks nothing for yield and quality compared with its sister class HRWW. What the HWWW class does